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GRAFTLESS IMPLANTS IN THE POSTERIOR MAXILLA

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ABSTRACT

The aim of this narrative review is to describe treatment options for implants in the posterior regions of the maxilla. The dental literature was screened for treatment options enabling the placement of dental implants in posterior sites. The posterior maxilla faces twin challenges like ridge resorption and sinus pneumatization following extraction. Hence, sinus elevation procedures were for long considered to be the gold standard using various bone substitute materials and rendering high implant survival rates. However due to inherent limitations in the technique and associated morbidity, graftless solutions are now gaining popularity. This paper reviews advantages and literature on use of short, angulated, zygomatic and pterygoid implants as graftless solutions in the posterior maxilla.

KEY WORDS: Implant, Posterior maxilla, Short, Angulated, zygomatic, pterygoid.

Dental Implantology is one of the most popular and intensively researched topics of current dental medicine. The necessity for the former complicated preprosthetic surgical procedures to facilitate the partial dentures has recently been decreased with the widespread construction of implant-supported prosthesis. Nevertheless, the alveolar deficiency that impedes the insertion of dental implants makes a number of similar reconstructive procedures inevitable. The posterior maxilla is one of the most challenging anatomic locations for the implant placement that requires adjunctive surgical procedures. This special issue covers leading researches and reviews on this topic that we believe would contribute to clinicians.

Insufficient bone quality and quantity in posterior maxilla is a common clinical state which makes the implant applications challenging in this site. The main reason for that is the pneumatization of sinus subsequent to the tooth loss and the concomitant excessive alveolar resorption. Insufficient subantral bone and coexisting increased interarch distance necessitate a combined sinus lifting and augmentation procedures. T. Kanno et al. reported the results of their retrospective study entitled *"*Simultaneous sinus lifting and alveolar distraction of a severely atrophic posterior maxilla for oral rehabilitation with dental implants*"* in which they performed combined sinus lifting and alveolar distraction osteogenesis in a case series with 27 individuals. The study revealed a histomorphometric similarity between the new bone formed by the presented technique and the bone generated via the sinus lifting only. They also accomplished stable implant rehabilitations within this topic.

The quality and the quantity of the host bone are the key determinants for successful dental implants. The quantity of the bone may be estimated via advanced radiological techniques in a high precision. However, a definitive accuracy cannot be pronounced although a number of techniques are available to evaluate the quality of bone. H. Bilhan et al. have reviewed the current techniques used for the estimation of the quality of the host bone while they simultaneously reported the results of a pilot experimental study that compares the densitometric evaluation of the dental volumetric tomography (DVT) with micro CT with their study entitled *"*How precise is dental volumetric tomography in the prediction of bone density?*"*. The results of this study revealed that the Hounsfield unit evaluation via DVT is not a reliable method to evaluate the density of bone.

C. Riben and A. Thor have published their review on "graftless augmentation procedures" which became a popular topic on sinus floor elevation, regarding a conventional surgical approach for the posterior maxillae. Their study entitled *"*The maxillary sinus membrane elevation procedure: augmentation of bone around dental implants without grafts-a review of a surgical technique*"* includes the technical details of the procedure.

The alveolar bone loss principally initiates with the tooth loss and this state may complicate the ideal placement of the implants. A number of surgical methods is advocated to prevent the bone loss. G. Pagni et al. reviewed these techniques in their study entitled *"*Postextraction alveolar ridge preservation in the molar area: biological basis and treatments*"*. The study provides comprehensive information about the socket healing and biology of the alveoloar bone resorption subsequent to extraction. They stated that the improvements in the grafting technologies would give rise to less invasive surgical interventions.

The recent advances in the implant surface characteristics led to major modifications in former fundamentals. An increased osseointegration rate with the improvement of the surface characteristics of dental implants resulted in a numerous successful reports for the implants shorter than 10 mm. Today, many companies appear in the dental market with their recently introduced 6 mm or shorter dental implants. Owing to this, clinicians now can be able to offer effective and noninvasive remedies to their patients avoiding advanced complicated surgeries in case of severe alveolar atrophy. Although a number of clinical reports reveals high success rates for the mandible, the use of short implants in the maxilla is still debatable especially for the single-tooth replacements due to its porous nature. D. Lops et al. compared the clinical success rates for 8 mm. Implants with that of 10 mm. In their long-term study entitled *"*Short implants in partially edentulous maxillae and mandibles: a 10 to 20 years retrospective evaluation*"*. In general, they declared similar success rates for 8 mm and longer implants. The results of this study revealed that the use of 8 mm implants seems to be safe in the posterior maxilla.

PTERYGOID IMPLANTS:

Placement of implants in the posterior maxilla is known to be challenging due to the quality and quantity of available bone and the presence of the maxillary sinus[1]. In an attempt to solve these problems, pterygoid implants were introduced. They were first described by TULASNE in 1989, who credited Paul Tessier with the idea of placing implants in this region[1,2]. The pterygoid implant is intended to pass through the maxillary tuberosity, pyramidal process of palatine bone and then engage the pterygoid process of the sphenoid bone[1,3].

Owing to their long path, the length of pterygoid implants ranges from 15 to 20 mm[1,2]. The implant enters in the region of the former maxillary first or second molar and follows an oblique mesio-cranial direction proceeding posteriorly, towards the pyramidal process. It subsequently proceeds upwards between both wings of the pterygoid processes and finds its encroachment in the pterygoid or scaphoid fossa of the sphenoid bone[3,4]. The pyramidal and pterygoid processes are composed of dense cortical bone and the average thickness of bone at their juncture is 6–6.7 mm[3,5]. If an implant is passed through this juncture at an angle of 45 degrees, it can incorporate up to 8– 9 mm of dense cortical bone and its apex protrudes 2 mm into the pterygoid fossa[3].

The primary reason for using pterygoid implants is the availability of dense cortical bone for engagement of the implant[2,3,6,7]. It also helps to overcome the need for

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maxillary sinus lift and grafting procedures[2,6]. This can shorten the treatment time and may allow immediate loading of the pterygoid implant[8]. It allows a prosthesis to have sufficient posterior extensions, which eliminates the need for detrimental distal cantilevers[6,8]. The disadvantages of the pterygoid implant are the learning curve and technique sensitivity associated with the procedure, proximity to vital anatomic structures and access difficulty for clinicians and patients[1,2,6]. It is radiographically difficult to assess the marginal bone loss around these implants due to the nature of their position[8].

ZYGOMATIC IMPLANTS:

Conventional implants have always been sensitive in the maxilla than in the mandible[9].The situation becomes undesirable when the maxilla is severely resorbed and atrophic, so various protocols have been recommended to provide an optimal solution for this complex problem.

A new technology was developed in Europe to do the upper jaw dental implant treatment without using the hipbone graft.

This „graft-less technique", also called the "Zygoma technique" uses the cheekbone (Zygoma bone) to anchor the longer zygomatic implants. The implant is a titanium endosteal implant. These are self-tapping screw-shaped implants in commercially pure titanium with a well-defined machined surface. They are available in eight different lengths ranging from 30 to 52.5 mm. They present a unique 45° angulated head to compensate for the angulation between the zygoma and the maxilla. The portion that engages the zygoma has a diameter of 4.0 mm, and the portion that engages the residual maxillary alveolar process a diameter of 4.5 mm.

Classification:

Aparicio C in 2011[10] proposed a classification for zygomatic implant patients based on the zygoma anatomy guided approach (ZAGA). The morphology of the lateral sinus wall, residual alveolar crest and the zygomatic buttress was taken into major concern.

The five basic anatomical groups were named as ZAGA 0, ZAGA 1, ZAGA 2, ZAGA 3 & ZAGA 4.

Indications Implants of Zygomatic:

1. Treatment of severely atrophic edentulous maxillae without using any bone augmentation, sinus lifting or other grafting procedures.
2. There is not enough bone in the frontal maxillary regions and two to three zygomatic implants can be used in each upper quadrant to hold a fixed prosthesis without using any conventional dental implants.
3. Free-end situations in maxilla with insufficient bone height.
4. Total edentulism together with reduced bone height.
5. Pneumatization of maxillary sinus, In cases with very severe resorption of anterior maxilla.
6. Maxillary reconstruction after partial or total maxillectomy. Zygomatic implants can be used to fix maxillary obturators as an alternative to non-implant retained obturators, local and regional flaps, and microvascular free flaps.

Contraindications of Zygomatic Implants:

1. Medically compromised patient
2. Acute sinusitis
3. Adequate maxillary bone for conventional implants
4. Severe trismus (relative contraindication)
5. Previous history of head and neck radiation therapy (relative contraindication)

Advantages of Zygomatic Implants:

1. Avoids use of grafts in atrophic maxilla
2. No additional donor site surgery and morbidity
3. Zygomatic implants placed with two to four traditional pre-maxillary implants can be either immediately loaded, or, more traditionally, a final fixed prosthesis can be placed after a 6- month healing period.
4. Good anchorage from tough zygomatic bone which enhances stability of prosthesis.
5. Zygomatic implants do not necessarily require hospitalization, which is usually needed for autogenous bone harvesting from the iliac crest.
6. The total treatment time is routinely 6 months or less for zygomatic implants compared with grafting with subsequent implant placement.
7. Less number of patient visits.
8. Fewer implants are required to support a prosthesis compared with traditional bone grafting and implant placement.
9. The overall laboratory fees are equal to or slightly less than those for traditional implants.

Disadvantages of Zygomatic Implants:

1. Difficulty in implant placement and a palatal emergence profile.
2. Because the platform of the zygomatic implant might be palatal to the crest, the perception is that the patient will feel excess bulk and have problems with the prosthesis. The restorative dentist must have the clinical proficiency to fabricate a full arch implant supported prosthesis, which could exclude dentists who do not have the clinical experience with this type of prosthesis.
3. The placement of the zygomatic implant is limited by the anatomy of the zygoma.
4. In patients with concave lateral walls of the maxilla, surgical placement of the zygomatic implant within the bone might be difficult. The surgical access to the zygoma and orbital rim requires a surgeon who has experience with surgery in this area.
5. Although the palatal emergence of the implant does add to the difficulty of maintaining oral hygiene, minimal long- term phonetic sequelae from the prosthesis design have been reported.
6. The surgeon must attain training for surgical placement of zygomatic implant.

Complications of Zygomatic Implants:

1. The reported complications associated with zygomatic implants include postoperative sinusitis, oroantral fistula formation, periorbital and subconjunctival hematoma or edema, lip lacerations, pain, facial edema, temporary paresthesia, epistaxis, gingival inflammation and orbital penetration/injury.
2. Post-operative concerns regarding difficulty with speech articulation and hygiene caused by the palatal emergence of the zygomatic implant and its effect on the prosthesis suprastructure.
3. Zygomatic implants were associated with periimplant bleeding and increased probing depths, possibly caused by difficulties in implementing appropriate hygiene because of the positioning of the zygomatic implant head and abutment, and the design of the prosthesis. Thus, the risk of soft tissue problems and sinusitis should not be underestimated.

SHORT IMPLANTS:

Introduction:

Short implants are increasingly being discussed as a treatment alternative in situations characterized by limited vertical bone height [11]. Compared to the use of standard implants, biomechanical considerations (e.g. crown-to--implant ratio, C/R) with short implants may lead to unfavorable loading conditions and complications, including excessive crestal bone loss and implant failure [12]. Improvements in implant design and surface along with the use of modified implant insertion methods all are intended to minimize these risks [13].

Definition of Short Implants:

Implants are usually referred to as short if their designed intrabony length measures ≤ 8 mm with diameters ≥ 3.75 mm. Standard implants are considered to be those with lengths > 8 mm and diameters ≥ 3.75 mm [14,15]. "Ultra-short" implants are considered to be those with lengths less than 6 mm [16].

Indications for Short Implants:

Short implants are primarily used to avoid bone augmentation procedures in the maxillary and mandibular posterior segments of partially edentulous patients. They are applicable if vertical bone volume is limited by anatomical structures (maxillary sinus, mandibular canal), but there is sufficient alveolar ridge width to permit successful use of implant diameters ≥ 3.75 mm. They are also used to support removable overdentures as single or multiple tooth replacements in the anterior jaws [15,17]

Guidelines for Short Implants:

Some authors have offered recommendations on using short implants that are mainly biomechanical in nature. These recommendations include:

Machine-surfaced short implants should not be used [18] Short implants should only be used if bone -quality is favorable [17] Restoration with single crowns on

short implants acceptable [19,20,21,22] Primary splinting of threaded short implants [23] Guiding surfaces for lateral movements should be avoided [24] Insertion at or below bone level with tapered abutment design [25] The implant surgeon and restorative dentist should have adequate training [22].

Short implants were introduced recently as a new approach to simplify implant placement in compromised alveolar bone and to prevent possible damage to vital structures[26].

There are many advantages to short implants including eliminating sinus augmentation procedures, lesser risk to mandibular canal, decreased contact possibility with adjacent tooth roots, lower risk of surgical paresthesia, less bone overheating, and lower risk of bone graft exposure. In addition, short implants lead to time and cost reduction and less patient discomfort[27]. Furthermore, short implants may not need computed tomography (CT) scans, since CT scans are usually invested for >10-mm-long implants or sinus augmentation surgery[28].

However short implant do face challenges such as less bone to implant contact due to reduced implant surface, more crestal bone resorption due to a reduced surface over which to distribute forces, and the increased crown-to-implant (C/I) ratio[28].

Short dental implants have been proposed as a treatment option to simplify implant placement in a compromised alveolar ridge, to avoid vital structures, to minimize surgical trauma, and to decrease the morbidity of advanced surgical procedures[29].

Some risk factors that may increase stress when using short implants are (1) increased crown height, (2) high bone density in the region, and (3) higher bite force. Some methods available to decrease stress include (1) minimizing the lateral force on the prosthesis, (2) lack of cantilevers on the prostheses, and (3) splinting multiple implants together[30].

The C/I ratio of short implants might increase the risk of biomechanical complication because of overloading/non- axial loading and can eventually result in crestal bone loss[31]. Occlusal table reduction, flattening the cuspal incline, and minimizing off-axis loads would contribute to more favor- able load distribution and potentially more success in implant treatment with short implants[32].

ANGULATED IMPLANTS:

Introduction:

Angulated standard implant designs or non-angulated ones placed in off-axis (tilted) positions are increasingly being used for the splinted reconstructions of edentulous jaws, again as an alternative treatment option to avoid hard tissue augmentation procedures, but also to increase primary stability for immediate loading procedures with longer implants [33]. The objective of having implants in a tilted position is to utilize as much bone as possible, while still avoiding vital adjacent structures (e.g. the mental foramen in the mandible or the maxillary sinus in the maxilla). They also increase the surface area for restorative support (through diverging implant axes) [34]. Restorations can be inserted on these implants via angulated abutments/multiunit abutments .

Advantages of Tilting Implants

1. Stability even in minimum bone volume: Longer implants can be used in minimum bone volume with advantage of increasing bone-to-implant contact and reducing the need for vertical bone augmentation.
2. Good clinical results.
3. Eliminates the need for bone grafting which is invasive with unpredictable outcome [35].
4. Can usually be performed in patients with various systemic conditions which are often contraindications for bone grafting [35].
5. The angulations allow placement that avoids anatomical structures [36].
6. There is a biomechanical advantage in using tilted distal implants rather than distal cantilever units [37].
7. Reduce the length of cantilevers without performing bone grafting or sinus lifting [38].
8. Effective and safe alternative to maxillary sinus floor augmentation procedures[39] and to pneumatised maxillary sinus [40].
9. Distally tilted implants induced better loading transmission[41] than vertical implants[42].
10. Excellent prognosis in short-medium term as well as in long term.

Disadvantages:

1. Procedure is highly technique sensitive.
2. Surgeon need to be very skillful.
3. Computer guided surgical stent required for implant to be placed in desired angulation.
4. Even slight change in angulation may pose restorative problems to patient and operator.
5. Long term studies are not adequately available.

Prevention of complications:

1. Placement of angulated and immediately restored implants should be effected with sufficient primary stability (and splinted with immediate restoration).
2. For anatomically and prosthetically correct angulated implant placement, a pre- operative 3D computer-based diagnosis is recommended.
3. The implant surgeon and restorative dentist must have adequate training.

CONCLUSION:

These implants offer an interesting alternative solution to bone grafting procedures in the severely resorbed posterior maxilla. They have been shown to give a predictable outcome in the rehabilitation of totally as well as partially edentulous patients without the use of bone grafts from extragenous/intraoral donor sites and hence should be considered as a valid treatment option.

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